A new selection model for the academic development programme for engineering at UCT

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The Academic Support Programme for Engineering at the University of Cape Town (ASPECT) has operated under a slowly evolving model since its inception in 1989. Different models of access and curriculum are frequently under consideration and in 2014 we had the opportunity to put into practice a new model, involving self-selection and delayed transition into ASPECT driven by first term assessment. In this paper we present a historical overview, reflect on the 2014 experiences of students and staff in light of relevant theory and conclude with an argument in favour of the delayed transition model.

Background and history of selection of ASPECT students

Prior to 2014, the admission of students into ASPECT, the Academic Support Programme for Engineering at the University of Cape Town (UCT), was based on offers made to students who applied to any of the 4-year BSc(Eng) programmes at UCT but whose final high school results and National Benchmark Test results gave a Faculty Point Score slightly below the entrance requirements. In line with transformation goals, these offers tended to be made to African and coloured students, reflecting the initial purpose of ASPECT as an intervention to address the low throughput of underrepresented South African black students who had been disadvantaged by apartheid (Sass, 1988; Meyer and Sass, 1992; Jawitz, 1994; Jawitz and Scott, 1997). Many students were the first in their families to attend university and many had earned a place at university by achieving high academic marks from the under-resourced schools (Kapp et al., 2014; Craig, 2013). Students could not apply for the 5-year BSc(Eng) programme but were offered a place in the 5-year programme if their admission into the 4-year programme was narrowly unsuccessful and they matched the underrepresented race groups.

The programme operates on an extended degree structure, spreading the credit load of the first two years of the 4-year programme over three years. Students do not take any courses below first year university level (i.e. no 'bridging' courses of high school content) but additional time for first year mathematics and physics courses allows for revision of school-level content to be built into the design of the courses, a model of "more time, more tuition" (Kloot, Case and Marshal, 2008) . The key features of the 5-year programme are more class time for mathematics and physics, a reduced academic load, frequent assessment with feedback, and a sense of community developed through active and cooperative learning in mathematics and physics and approachable lecturers who quickly get to know all the students. Typical class sizes range from 60 to 90. A full description of the ASPECT programme is given in Pearce et al. (2015).

In addition to students who started in the 5-year programme, a small number of students would join the 5-year programme during or after the first semester. Students failing multiple subjects after the first class tests or after the first semester were counselled to consider moving to a structured 5-year programme. Counselling was through emails and face-to-face interviews with academic development lecturers within each engineering department and ASPECT staff. The strongest motivating factor for a move into the 5-year programme after failing multiple first semester courses was the reduction in the number of credits needed to avoid being academically excluded from the university at the end of the first year, due to spreading the 576 credits for the degree over 5 years rather than 4 years which typically reduced the number of courses from five to three per semester in the first year.

The model ASPECT had operated on for several years prior to 2014 therefore involved a cohort of students

who were in ASPECT from the beginning of their academic first year, joined by a smaller number of students later in the first term, or even second term. These transitioning students were generally few in number and joined at staggered intervals, not all at once. No model is perfect and we were pleased to inadvertently be allowed to trial a new model in 2014.

The new model: Delayed transition and self-selection

In 2014, an unanticipated high number of candidates with provisional offers of acceptance into the 4-year BSc(Eng) programmes achieved the minimum marks required for automatic acceptance. As a result, no offers were made for places in the 5-year programme for fear of exceeding capacity. In line with the results from student performance in previous years, and recent reports on the low percentage of students nationally who graduate in minimum time (Council on Higher Education, 2013; Scott, Yeld and Hendry, 2007), it was expected that a significant number of students would need longer than 4 years to complete their degree. Since the provisional offers for the 4-year programme could not be changed to offers for the 5-year programme, plans were made for constituting an ASPECT class after the first term tests.

At orientation in the beginning of the academic year as well as in special sessions after the first tests were written, students were advised to switch to a 5-year programme if they were failing multiple subjects. These group advice sessions were followed up by emails to targeted students inviting them for one-to-one counselling regarding their curriculum planning. At the start of the second term, students who agreed to move to a planned 5-year programme reduced the number of courses per semester from five to three (in most cases) and switched to double-contact classes for mathematics and physics, taught by ASPECT lecturers. No students were forced to change their programme, however the risk of exclusion as a result of remaining on a regular load and failing to pass sufficient courses was emphasised. The result was a self-selected cohort based on the results of the first class tests and counselling. These self-selected students all transitioned to ASPECT within the first week of the second term.

These unexpected circumstances gave us the opportunity to compare and contrast the implementation and effects of the new and old selection model, to reflect on our findings and to consider theoretical explanations for or against the new selection model.

Observations

Over the course of the challenging second term of 2014 and the slightly more stable second semester, we as staff observed and experienced positive and negative effects of the new model. The new model gave rise to a class with greater diversity and a more positive attitude towards interactive learning than in previous years. Shifting to ASPECT gave students a clear advantage with respect to passing mathematics and physics due to the replacement of their first, low test marks with new assessments of the first term's content.

The self-selection model was not without its challenges, including that work already ostensible covered had to be revised, contact time with the ASPECT staff was decreased compared to starting the year with an ASPECT class, logistic issues of administrative work and venue booking were onerous, sponsors could be unwilling to accept the change and students may have experienced identity struggles due to high stakes failure, often for the first time in their lives. Despite the challenges of the new model, we argue that the benefits outweigh the constraints.

The new model allowed for a direct comparison between students with similar academic records yet who made different decisions with respect to transitioning to ASPECT. We present the results of one possible analysis here. Our focus on data included in this paper is on student performance in the first and second semester courses in first-year mathematics and physics, a total of four semester courses, as failing these is most likely to increase the time to graduate beyond 4 years. Results for students in 'repeat' courses were excluded from our analysis. In order to compare the benefit of moving to the 5-year programme with staying in the 4-year programme, the 2014 year-end results of students who moved to the 5-year programme were compared to the results of students who were advised to move but chose to stay in the 4-year programme. These results were split to into two groups: students who failed both mathematics and physics first tests (Table 1) and students who failed either mathematics or physics (Table 2). Although students in the 5-year programme have different assessments in mathematics and physics from the equivalent courses in the 4-year programme, the course content is the same and the courses share the same external examiners to ensure the same academic standards in the courses.

A total of 49 students out of a cohort of 575 failed both first tests for mathematics and physics. Of these, 24 students moved to the 5-year programme after the first term. A large majority of that 24 (19 students, 79%) passed all mathematics and physics semester courses or failed at most one course. Four students

(17%) only passed one or two courses, and one student failed all courses. There were 25 students who failed both mathematics and physics tests but chose to stay in the 4-year programme after the first term. Their year-end results were worse. Only 6 students of the 25 (24%) passed three or four courses, 10 (40%) only passed one or two courses, and 9 (36%) failed all courses. Failing multiple semester courses in the first year greatly increased the chance of academic exclusion at the end of the first year due to slow progress. It also increased the financial burden of the students as full fees are required when repeating courses.

Table 1. Year-end results of students who failed both mathematics and physics first tests.

		Number of mathematics and physics semester courses passed in first year		
	N	4 or 3	2 or 1	0
Number who shifted to 5-year plan	24	19 (79%)	4 (17%)	1 (4%)
Number who stayed in 4-year plan	25	6 (24%)	10 (40%)	9 (36%)
Total	49			

A similar pattern appears in the year-end results of 116 students who failed the first test in either mathematics or physics, detailed in Table 2. A total of 19 out of the 25 students (76%) who moved to the 5-year programme went on to pass all or most of their mathematics and physics semester courses. The comparative number for students remaining in the 4-year programme was 55 out of 91 students (60%). Relatively more students staying in the 4-year programme failed all or most mathematics and physics semester courses compared to students who shifted to the 5-year programme: 36 out of 91 (40%) compared to 6 (24%) for students who shifted.

Table 2. Year-end results of students who failed mathematics or physics mid-semester tests.

		Number of mathematics and physics semester courses passed in first year		
	N	4 or 3	2 or 1	0
Number who shifted to 5-year plan	25	19 (76%)	6 (24%)	0 (0%)
Number who shifted to 4-year plan	91	55 (60%)	23 (25%)	13 (14%)
Total	116			

Discussion

The most obvious change apparent in the new cohort was the increased racial and socio-economic diversity of the class. Previously the overwhelming majority of the class were African students with most of the remaining students coloured, many with low socio-economic status (Craig, 2013; Pearce et al., 2015). The new cohort had white students making up a quarter of the class and there was greater diversity in backgrounds with more students from private schools or well-resourced government schools. The wider mix of backgrounds in the students stimulated more questioning in class and, we hypothesise, may have contributed to reducing the stereotype of the ASPECT student as coming from a disadvantaged background and being academically weak. Pym (2013) notes that having a separate academic support programme increases the possibility of students underperforming due to stereotype threat (Steele & Aronson, 1995).

The active and collaborative teaching approach in the ASPECT mathematics and physics classes remained unchanged from previous years under the new selection procedure. However, there was a sense from lecturers that the class was more receptive to working in groups compared to previous cohorts. In a review on student engagement, Zepke and Leach (2010) linked higher levels of student engagement with a willingness to exert agency, citing Yorke and Knight (2004)'s finding that students with malleable rather than fixed self-belief are more likely to stay engaged despite not reaching learning goals. The greater engagement in group work by the self-select cohort suggests that students who chose to shift to the 5-year programme may be more likely to have malleable self-belief.

A move to the 5-year programme is a positive step that a student can make when they are confronted with test mark evidence of not managing their academic load. Since the first class test contributes up to half of

the class mark in a course, and a minimum class mark of 35% is needed to be allowed to write the exam, obtaining a very low mark for the first test makes it more likely that a student will fail if they remain in the 4-year programme. If a student moves to the 5-year programme, their first test mark is not counted and the content is reassessed after it has been revised. Support for students who remain in the 4-year programme include optional tutorials in evenings and Saturday mornings, 'hot-seat' tutorials for one-to-one help, consultations with lecturers and online quizzes on Webwork for mathematics.

Either entering the university via the 5-year programme (as in the previous model) or shifting to the 5-year programme after one term (as in the new model), requires the students to grapple with the shift in self-perception of "top academic achiever" in their schools to "student at risk" in an extended programme. Many students receiving a failing mark in the first tests are experiencing academic failure in a high-stakes assessment for the first time in their lives. To help with the difficult decision of whether or not to transfer into the 5-year programme, each student wishing to move to the 4-year programme is interviewed by the ASPECT coordinator or deputy coordinator who looks at all their results, including National Senior Certificate results and National Benchmark Test results and questions the students on their approach to their studies. A qualitative judgement call must be made on how that student is performing, taking into account how they claim to be working and what sporting, volunteer or personal commitments they have. A small number of students are advised to remain in the 4-year programme. Although these interviews are intensely time consuming, direct contact with a staff member has been shown to be a significant factor in students deciding to remain at university (Tinto, 1990; Kuh, Kinzie, Schuh and Whitt, 2011). The impact of confidence, morale and identity cannot be ignored, such affective issues have great impact, and the new model of self-selection might assist the students to perceive themselves less as "students at risk" but more as "students who are solving their problems".

The first and second semester mathematics and physics courses in the 5-year programme cover the same content as the equivalent courses in the 4-year programme. However, when students move into these courses mid-semester, it is necessary to revise the work covered in the first term before moving forward with the remaining content due to the hierarchical knowledge structure of the content (Gray, Pinto, Pitta & Tall, 1999). Two mathematics and two physics lectures are timetabled for each day to allow for revision. The work is intense and remains at a fast pace. Scheduling examinations late in the examination timetable allows for revision workshops to be scheduled in the study break before examinations start. The work demand on students is high and some are not able to assimilate the course content sufficiently quickly and still fail to meet a minimum passing grade of 50% for all courses. Tables 1 and 2 indicate, however, that those students who shift to ASPECT still succeed at a higher rate than the students who chose to stay in the 4-year programme.

Compared to the previous model in which students started with a reduced academic load and additional time for mathematics and physics, shifting after the first term reduces the contact time in these courses by 25%, and time that they would have spent on new content in the second term now needs to be spent revising work from the first term. From this perspective, more assistance is offered to students when they are placed in the 5-year programme from the start of their degree.

Starting the year on a 5-year programme may seem more expensive due to the extra year of accommodation costs. However, if a move to the 5-year programme prevents failure, students experience a financial advantage by not paying course fees to repeat the failed courses. The ASPECT mathematics and physics courses in the 5-year programme are the same price and credit value as the equivalent courses in the 4-year programme despite the additional contact time. Moving to the 5-year programme changes the distribution of the course fees over five years instead of four. The only additional costs are accommodation and living expenses for an additional year of full-time study, and inflation-related increases in course fees from year to year.

The administrative work involved with shifting to the 5-year programme in the middle of the first semester is high. A live document recording students who plan to move is compiled by the deputy coordinator in ASPECT in order to help reorganise tutorial, practical and lecture groups to fit the venues with balanced numbers. It is also difficult to know how many students to expect and book venues accordingly. In 2014 only 49 students moved into the 5-year programme but in 2015 this number increased to 107. That being said, it has always been challenging to predict numbers in ASPECT; the self-selection model simply delays that challenge by one term.

A letter explaining the structure of the 5-year programme is sent to sponsors of students who plan to move, explaining that the total fees for the degree remain unchanged (see appendix 1). Some sponsors are still reluctant to sponsor for an additional year, despite historical data reporting that only a minority

of students in the 4-year programme graduate in minimum time (Council on Higher Education, 2013; Scott, Yeld and Hendry, 2007).

Questions for Further Research

While the self-select model encourages students to be proactive in directing their university experience, the high entrance requirements for a BSc(Eng) restrict the group to high achievers, who may struggle with identifying themselves as needing support. The risk of the current selection model is that students who are advised to switch to a 5-year programme but choose not to may fail, incurring expenses and risking exclusion. The link between self-belief, engagement and academic achievement (Zepke and Leach, 2010; Yorke and Knight, 2003) may explain why those who choose to switch to a 5-year programme outperform those to remain in the 4-year programme. Similarly, if students hold a fixed mindset regarding academic ability rather than a growth mindset (Dweck & Master, 2008), recovery from the shock of failing may take longer. Further studies would be needed to identify if there is a difference in the self-belief and learning mindsets of students who do or do not switch to the 5-year programme, and if this is related to the academic achievement of these students.

Statistics for the 2014 and 2015 cohorts will help to identify indicators that could make a switch to the 5-year programme mandatory, particularly with the move to an admissions policy from 2016 based on an index that proposes to measure previous disadvantage (Price, 2014). A statistical analysis of the progress of the 2014 and 2015 students will also help to answer the question, If places are limited, how do we determine those students most worthy of additional support?

The large difference in the number of students who chose to shift to the 5-year programme in 2015 compared with 2014 (107 and 49 students, respectively) was largely due to differences in the test marks for mathematics and physics. This raises the question, Are the first tests written at university a good indicator of future success? A study by Lee, Harrison, Pell and Robinson (2008) showed that a mathematics diagnostic test was the best predictor of overall performance in first year engineering, suggesting that early assessment can be a good indicator, however analyses with our students have showed low correlation between performance in a mathematics diagnostic test and students' performance in mathematics courses (Craig and Campbell, 2013).

Students who are academically proficient also join the programme and use resources. Should we be preventing students who feel that they are not coping from switching? What additional academic support can be given to students remaining in the 4-year programme and should the responsibility (and cost) for additional support be placed on the service departments or on the Faculty of Engineering and the Built Environment who select the students?

The challenges and benefits involved in the self-select model suggest that a hybrid selection model could be considered, whereby some students are admitted directly into the 5-year programme and another cohort moves to the 5-year programme after the first tests. Given the revision that the latter group would need, the classes might need to be run separately, and this split has staffing and venue implications.

Conclusion

The self-select model highlights the need for more opportunities for students to receive feedback on their progress, particularly in mathematics and physics, before the first class test. Students' initial high confidence, based on a history of excellent achievement in mathematics and science in school, may exacerbate the shock of failing their first term tests. Theory suggests that students with growth mindsets and malleable self-belief may be better positioned to recover from academic failure.

The shift to a self-selected cohort has given an opportunity for statistics to be gathered that can help in advising students on whether or not to change to the 5-year programme. While it is possible for students to graduate in 4 years if they fail a first semester course, it usually requires 5 or more years to complete the degree. The 2014 year-end results show a clear advantage in shifting to the 5-year programme in terms of reducing the number of mathematics and physics semester courses failed, which has a financial advantage to students.

It is too early to see what impact the self-select shift to the 5-year programme will have on graduation rates. It would be worse for students to avoid exclusion in their first year through joining the 5-year programme, only to be excluded in later years when they have incurred more expense. The difficulty is knowing how students will develop and whether they can meet the changing demands of the engineering degree in the planned time framework. Some students who get excluded complete credits through distance learning institutions and return to graduate at UCT, indicating that exclusion does not correspond to a student being unable to meet the demands of the degree.

The role ASPECT has played in the country's higher education transformation process, along with other similar programmes, has had significant success in the last 26 years (Badat, 2013). The country has changed in many ways over the years of the programme's existence and it is reasonable that ASPECT changes accordingly. While the focus of ASPECT has always been at least partly on equity of access for all South Africans, equity of outcomes is as important (DoE, 1997) and perhaps gaining in relative importance as demographic factors shift and change. The new model of self-selection has many advantages over the previous models, however our attention must remain on the continued progress of these cohorts of students over the next few years to assess throughput rates. Our observations during 2014 leave us hopeful that the engagement and agency demonstrated by these self-selected ASPECT students will reap success in the years to come.

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Appendix 1: Email letter to sponsors explaining about the 5-year programme

Dear Sponsor

The University of Cape Town strives to maintain the highest academic standards in order for our students to graduate with an internationally accredited degree. Aligned with this we have systems in place that evaluate the performance of our students so that we can advise them on making sound academic choices.

In the Engineering and the Built Environment (EBE) faculty we find that the most of our students struggle with the heavy load in their first year of studies. The transition from school to university both academically and socially is difficult for many of our students. The academic support programme in the EBE faculty, called ASPECT, is designed to identify students who are struggling with the heavy load in first year. These students are then streamed onto an extended program to establish good foundational understanding so that they can move confidently into the more difficult engineering courses in the later years.

We have just completed our evaluations and we are in a position to identify and advise these struggling students. One of the students your company/institution/department is supporting financially, _____, has been identified and advised by us to consider transferring onto the extended program. This advice is not given lightly and many factors are taken into consideration, including Matric, NBT, diagnostic testing and current course results.

The implications are that the time to graduate for the student will be extended by one year, i.e. 5 years to graduate. The same courses are taken as the regular 4 year programme, but these will be spread over 5 years so that extra support can be given on the core subjects in the first year. To achieve this students switching to the programme will have to "postpone" one or two courses this year in order spend more time on the core subjects. These "postponed" subjects are will then be taken next year in the 2nd year along with some carefully selected 2nd year subjects.

There are no costs associated with transferring onto the ASPECT programme. Any fees already paid this year for courses that will now be "dropped" will be credited to the student fee account and this can be used to pay for the courses when they are taken in the following year.

Also, students on the programme are still eligible to graduate with honours if the requirements of finishing in 5 years and maintaining a high average in courses are met.

We usually send out this communication to sponsors to assure you that we are trying to make the best decisions in assuring the success of each student and improve the chance to graduate. _____ will also be making contacting with you to inform you of the advice been given and to hear your response.

If you have any further questions or queries please feel free to contact me. I have also included on this email a document answering the usual questions students ask me when we advise students for you to look at.